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NATIONAL BUREAU OF STANDARDS REPORT

4291

EVALUATION OF THE BOSTITCH STAPLER METHOD FOR APPLYING ASPHALT SHINGLES

By

W. C. Cullen

H.R. Snoke

For

Underwriting Division

Federal Housing Administration

NBS

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

U. S. DEPARTMENT OF COMMERCE
Sinclair Weeks, *Secretary*

NATIONAL BUREAU OF STANDARDS
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- **Office of Basic Instrumentation**
- **Office of Weights and Measures**

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PROJECT NO.
1004-40-4844

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1. INTRODUCTION.

The Underwriting Division, Federal Housing Administration, requested the National Bureau of Standards to evaluate the performance of Asphalt Shingles applied with the Bostitch H-4 stapling hammer, using 3/4 in. staples.

Acceptance of asphalt-shingle roofs applied with staples has been withheld by the Federal Housing Administration because shingle manufacturers have not indorsed the use of staples.

The principal advantage claimed for the stapling method was a saving in labor cost ranging from 20 to 35 percent. The stapling method is only recommended for new-roof work.

2. METHOD.

The Bureau proposed to make its evaluation by two methods; field studies of actual roofs applied with staples in areas representing various climatic conditions, and laboratory studies to determine resistance to tear.

In the field studies, particular attention was directed to:

a. Appearance of roof.

b. Behavior of stapled shingles in areas where wind damage to asphalt shingles was known to occur.

c. Resistance of staples to corrosion in service.

d. Retention of holding power of staples.

e. Positioning of staples (randomness).

Laboratory studies were proposed to determine:

a. Relative resistance to tear of asphalt shingles applied by nailing and by stapling, with staples placed horizontally, vertically and at an angle of 45° to the base line of the shingles.

b. Practicability of the stapling method for applying asphalt shingles to 5/16 in. plywood decks.

While not listed as a specific task, word done by other laboratories, where significant, has been included.

3. FIELD INSPECTIONS.

3.1 General.

Field inspections were made on structures located in 9 states and the District of Columbia. The areas varied greatly in climatic conditions. Numerous structures, representing the construction of some 25 builders, were inspected critically and many hundreds more were observed from the ground. The selling price of the houses inspected varied from $10,000. to $50,000. Many had been accepted for F. H. A. mortgage insurance.

Many contractors and roof mechanics were interviewed to obtain their opinions regarding the advantages or disadvantages of using the stapling method for the application of asphalt shingles. Occupants of dwellings with stapled roofs were also asked to express satisfaction or dissatisfaction with their stapled roofs.

This field work could not have been accomplished without

the cooperation of the National Association of Home Builders. The Washington office of this organization assisted in locating developments where the stapling hammer was used and arranged with member contractors in the field to assist Bureau representatives by providing transportation, ladders and other facilities. The authors express sincere appreciation for the excellent cooperation, both in Washington and in the field.

1.2 Locations Selected.

1. Camp Rucker, Alabama.
2. Baltimore, Maryland.
3. Dayton, Ohio.
4. Seattle, Washington.
5. Washington, D.C. and Maryland Suburbs.
6. Peoria, Illinois.
7. Lansing, Michigan.
8. Providence, Rhode Island.
9. Boston, Massachusetts.
10. Savannah, Georgia.

Progress reports made during the course of this investigation have described inspections in Dayton, Ohio; Seattle, Washington; Peoria, Illinois; Lansing, Michigan; Providence, Rhode Island; Boston, Massachusetts; and Savannah, Georgia. The following is a general summation of the observations reported in the progress reports:

3.3 Observations.

3.3.1 Appearance.

The appearance of the asphalt-shingle roofs applied by the stapling method was generally good. They appeared no different from shingles applied by the conventional nailing method. Regardless of the fasteners used, the appearance of the shingles depended upon the condition of the roof deck, the materials used and, most important, the skill of the shingle applicator.

3.3.2 Resistance to Wind.

Evidence of failure of stapled asphalt shingle roofs caused by wind was observed on structures at Camp Rucker, Alabama; Peoria, Illinois; Lansing, Michigan and Boston, Massachusetts. In the other six areas visited, no wind damage was reported or observed.

On many roofs at Camp Rucker, Alabama, both nails and staples were used. However, neither type fastener was responsible in any way, for the wind damage. The shingles had been exposed approximately 14 years and were very brittle. When subjected to high winds, the shingle tabs broke off at a line where the next course of shingles overlapped.

The wind damage reported at Boston and Peoria occurred during unusually severe windstorms and, at Peoria, it was reported that nailed shingles were damaged to at least the same extent.

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On many roofs at Camp Rucker, Alabama, both nails and staples were used. However, neither type fastener was responsible in any way, for the wind damage. The shingles had been exposed approximately 15 years and were very brittle; when subjected to high winds, the shingle tabs broke off at a line where the butt edges of shingles over-lapped.

The wind damage reported at Boston and Peoria occurred during unusually severe windstorms and, at Peoria, it was reported that nailed shingles were damaged to at least the same extent.

In one development of a hundred dwellings, at Stony Brook Village near Boston, it was reported that half of the asphalt-shingle roofs were stapled and half were nailed. It was reported also that wind damage resulting in insurance claims amounting to approximately $500 was suffered by the stapled roofs during one of the 1954 hurricanes, while the damage to the nailed roofs was considerably less than that.

Inspection of the roofs at Stony Brook Village showed that only four staples per shingle were used and that most of the staples were placed too high. On the nailed roofs, four nails were used per shingle, but the nails were placed correctly.

In every case of wind damage reported on either nailed or stapled shingles, the shingles were torn, leaving the fasteners in place. This would indicate adequate holding power for both nails and staples. Relative resistance of nailed and stapled shingles to tearing is reported in section 4.1.4.

3.3.4 Resistance of Staples to Corrosion in Service.

No serious corrosion of the staples was observed. A white, salt-like formation which appeared to be an oxidation product of the zinc coating was noted on the crown of a number of staples. A slight rusting was noted on the crown of some staples which had been exposed more than 10 years. No corrosion was observed on the legs of staples. Serious

rusting was observed only on staples exposed directly to the weather.

Any corrosion observed was not considered sufficient to impair the life of the staples during the life of the shingles.

3.3.5 Retention of Holding Power of Staples.

On practically every roof examined it was possible to find staples that had come loose. However, staples are apparently less likely to come loose than nails. The number of loose staples found on any roof was insignificant. No case was reported where the use of staples contributed to a leaky roof.

3.3.6 Positioning of Staples (Handedness).

The practice of placing staples too high was found to a lesser or greater extent on roofs in all areas visited. In many cases the staples were applied up to 3 in. above a line drawn through the top of the cut-outs or 1 in. above the head-lap. This defect in the application of asphalt shingles is frequently found regardless of the type of fasteners used and probably contributes more to the premature failure due to wind than any other cause.

The improper placement of the staples was attributed to the careless or, in many cases, the misinformed applicator.

The positioning of the staples on 90 percent of the roofs inspected, in relation to the long axis of the shingle, ranged from parallel to perpendicular and at angles between. This condition occurred as a result of the applicator reach-

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible] as a result of the [illegible] ing to the left and to the right as far as possible without changing position. Many contractors felt that the haphazard positioning is a definite advantage to the tearing-through resistance, while others claimed it is definitely better to have all staples positioned in such a manner that they are parallel to the long axis of the shingle. Resistance to tearing of nailed shingles and of shingles with staples placed parallel, perpendicular and at an angle to the base line of the shingle is given in Section 4.1.4.

4. LABORATORY STUDY.

4.1 Resistance to Tear of Nailed and Stapled Shingles.

4.1.1 Laboratory tests were devised to determine the resistance to tearing of shingles fastened with one and two nails and with staples placed parallel, perpendicular and at an angle of 45° to the base line of the shingle.

4.1.2 Materials:

Plywood panels, 3/8 by 4 by 7 in.

Strips of thin portion of thick-butt asphalt shingles, 4 by 5 1/2 in.

Strips of thick portion of thick-butt asphalt shingles, 4 by 7 1/2 in.

Bostitch 7050 3/4-in. staples.

Roofing nails - 3/8-in. diam. head.

4.1.3 Procedure.

To simulate actual application, the thicker shingle strips were applied to the plywood panels over the thin strips. When two fasteners were used, they were placed 3/4 in. above the line drawn through the top of the cut-outs and spaced 3 in. apart. When a single nail was used it was placed 3/4 in. above a line drawn through the top of the cut-outs, in the center of the shingle strip.

All specimens were conditioned at 73°F and 60% RH for a period of 48 hours and tested under those conditions.

In testing, the plywood panels were held rigidly in a horizontal position. The loose end of the shingle strip was gripped in the jaw of a Scott testing machine. The strips were torn from the fasteners by a direct vertical pull, with the jaw of the testing machine moving at a rate of 12 in. per minute.

4.1.4 Results.

The results, expressed in pounds of force required to tear the shingle strips from the fasteners, are given in Table 1.

TABLE 1.

Spec. No.	Tearing Resistance of two staples, in pounds, position			Tearing Resistance in pounds	
	Parallel	Perpendicular	45°	One nail	Two nails
1	22.5	21.0	21.5	21.0	33.5
2	20.5	23.5	22.0	17.5	43.5
3	16.0	18.0	21.0	17.0	33.5
4	20.5	20.0	22.5	17.5	34.5
5	22.5	22.0	21.5	22.5	34.0
6	27.0	20.0	20.0	19.0	40.5
7	27.0	22.5	23.5	22.5	31.5
8	24.0	20.0	20.0	21.5	37.5
9	22.0	22.0	23.0	24.0	38.0
10	20.5	18.5	22.5	20.0	30.0
Average	21.2	21.0	21.8	20.5	35.5

The results of the tearing tests indicate that two staples, however positioned, are roughly equivalent to one nail in resistance to tearing. They also indicate no significant difference in resistance to tear with staples placed parallel, perpendicular and at an angle of 45°.

The kind of tear resulting is shown in Figure 1. When the staples were placed parallel to the base line of the shingle, the shingle strip tore completely from the staple, leaving only a small break the size of the staple crown as shown in specimen A., Figure 1. The kind of tear with the staples placed perpendicular and at an angle of 45°, specimens B and C, was similar to that shown by the nailed specimen D.

4.2 Practicability of the Stapling Method for Applying Asphalt Shingles to 5/16 in. Plywood Decks.

Laboratory work to determine the practicability of the stapling method for applying asphalt shingles to 5/16 in. wood decks. Such work was considered unnecessary after observing shingles which had been applied to 5/16 in. plywood decks with no apparent difficulties.

5. WORK DONE BY OTHERS.

5.1 Forest Products Laboratory, Forest Service, Department of Agriculture.

The accompanying report, "Direct Withdrawal Resistance of Bostitch Staples and Standard Shingle Nails," by W. G. Youngquist and G. E. Heck, concludes that, "For the same depth of penetration, the staples had roughly one-third

The results of the bearing tests indicate that two staples, however positioned, are roughly equivalent to one nail in resistance to twisting. They also indicate no significant difference in resistance to twist with staples placed parallel, perpendicular and at an angle of 45°.

The kind of test resulting is shown in Figure 1. When the staples were placed parallel to the butt line of the shingle, the shingle strip tore completely from the stapling leaving only a small patch the size of the staple crown as shown in specimen A, Figure 1. The kind of tear with the staples placed perpendicular and at an angle of 45°, specimens B and C, was similar to that shown by the nailed specimen D.

4.3 Practicability of the stapling method for applying asphalt shingles to 5/16 in. plywood decks.

Observations were to determine the practicability of the stapling method for applying asphalt shingles to 5/16 in. wood decks. There were six weathered experimental strip covering shingles which had been applied to 5/16 in. plywood decks with no apparent difficulties.

5. CONCLUSIONS OF OTHERS.

5.1 Forest Products Laboratory, Forest Service, Department of Agriculture.

The accompanying report, "Direct Withdrawal Resistance of Machine Staples and Standard Shingle Nails," by R. O. Blomquist and R. G. Beck, concluded that, "For the same depth of penetration, the staples had roughly one-third

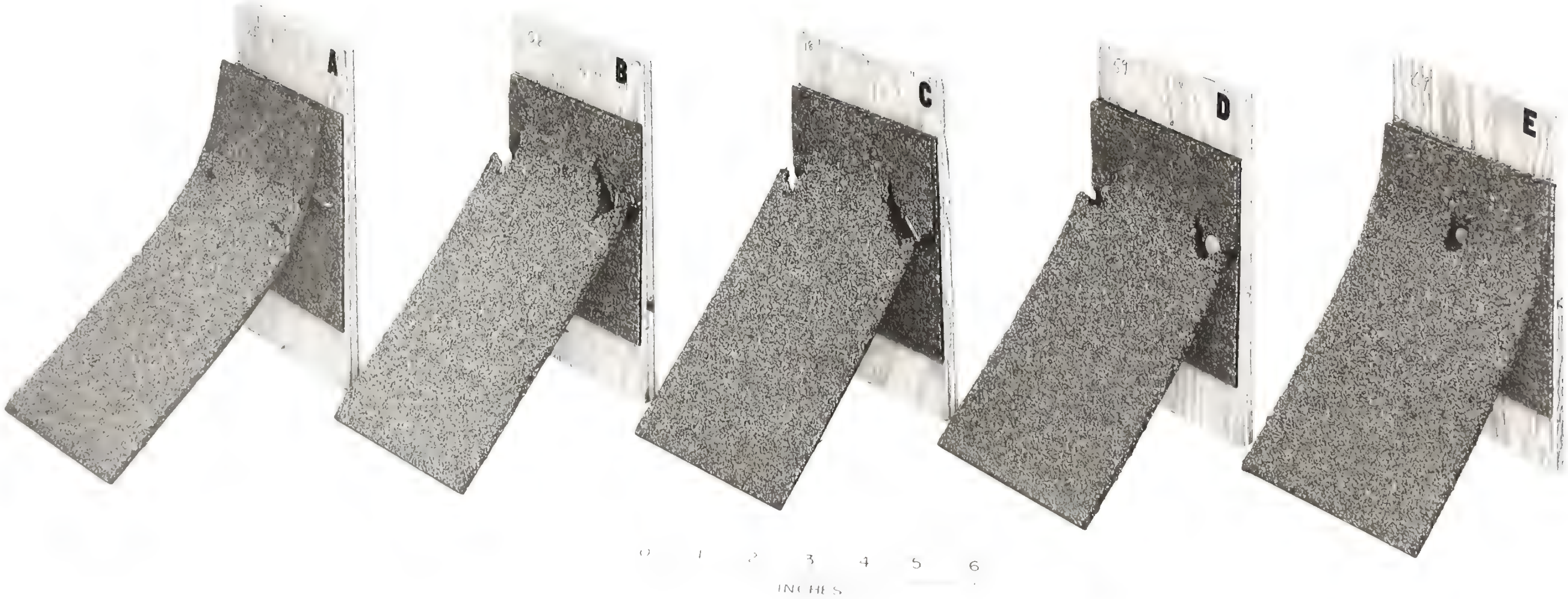

FIGURE 1. RESULTS OF TEARING TESTS

less holding power than the asphalt-type shingle nails with which comparisons were made."

This disparity in direct withdrawal resistance has no particular significance in the light of the reports of wind damage in the field where it was always reported that the shingles tore from the fasteners, either nails or staples, before they were pulled loose. (One third-hand report stated that in one case where more than a square of stapled shingles was removed from a single roof area during a hurricane, the staples were pulled from the deck. This report was not verified.)

The results of the resistance to tear tests also indicated that both nails and staples have adequate withdrawal resistance.

5.2 University of Washington Aeronautical Laboratory.

The accompanying report No. 350 "Wind Tunnel Tests of Several Types of Asphalt Shingles with Various Methods of Attachment," by J. W. Howell and R. O. Joppa, is submitted somewhat reluctantly. Reluctance is due to the fact that only one test each of stapled and nailed shingles permits a direct comparison of the two methods. These were of Panels Nos. 10 and 11, described as Runs 21 and 22 and illustrated on pages 23 and 25. If taken as significant it would indicate that stapled shingles would be torn with winds of lesser force than the nailed shingles.

The data are obviously inadequate for establishing definite limitations of wind velocity for either type of fastener.

It is our understanding that, on the basis of this report, the roofing company for whom the tests were made withheld approval of the stapling method of applying shingles.

Both reports cited in this section are confidential and should not be referenced or reproduced.

5. SUMMARY AND CONCLUSIONS.

Field studies of stapled asphalt-shingle roofs up to 14 years old in nine states and the District of Columbia have shown the following:

1. Satisfactory appearance of stapled shingles.
2. No serious corrosion of staples.
3. No connection between the use of staples and the incidence of leaks.
4. Adequate retention of holding power of staples.
5. Strong indorsement of the stapling method by most builders, roofing contractors and roof mechanics who had used it. (Only one builder who had used the method had stopped using it for reasons other than non-acceptance by F. H. A.)
6. General satisfaction of home owners with stapled roofs.
7. A possible greater tendency to place staples improperly than nails, though this was not the subject of a definite statistical study.

Items 1, 2, 4, 5 and 6 are positive findings of an actual field study, without reference to the opinions of others. Item 3 could be based only on reports of others and item 7 is based on general experience with nailed and stapled shingles.

One of the major questions concerning asphalt shingles applied by the stapling method has been whether the staples provide adequate wind resistance. To resolve this question properly it is necessary first to define adequate wind resistance for asphalt shingles.

The term might be defined as the resistance to winds necessary to keep the shingles on the roof deck. If this were accepted, there would appear to be no question but that nails are superior to staples, and that less wind is required to remove stapled shingles than nailed shingles. This must be concluded from the tests at the University of Washington, from the reports from Stony Brook Village and from our laboratory tearing tests.

However, that is not a satisfactory definition, because experience has shown that, with both nails and staples, winds strong enough will tear the shingles from the fasteners, so that neither type of fastener used alone could be considered adequate.

To have adequate wind resistance, an asphalt shingle should be so applied that it remains in its natural position at all times without distortion or bending. Initial distortion is not a function of either the nails or staples used to fasten

it but rather of the stiffness of the shingle, assuming the correct placement of the fasteners.

Any bending of an asphalt shingle may be injurious to the shingle. This is recognized by the Federal Housing Administration in the requirement that the tabs of shingles shall be spot cemented or otherwise secured in areas where high winds are a hazard, and by the Asphalt Roofing Industry Bureau in the recommendation that the tabs of shingles be cemented down in windy areas. (1).

With the conception that for adequate wind resistance asphalt shingles must be prevented from bending, the question as to whether nails or staples are used is largely academic, since neither will prevent the bending.

From the foregoing, the following conclusions are drawn:

1. That asphalt shingles applied in accordance with the instructions of the Bostitch Company, with six staples per shingle (See Figure 2.) will serve as well as nailed shingles in areas where high winds are no hazard.

2. That winds of high intensity will damage stapled shingles more than nailed shingles, if the same number of fasteners is used in each case and the tabs are not cemented down. Also that six staples should give approximately the same resistance to tearing as four nails under these circumstances.

(1). "Manufacture, Selection and Application of Asphalt Roofing and Siding Products," Fifth Edition, 1953, page 38. Published by the Asphalt Roofing Industry Bureau, 2 W. 45th Street, New York, New York.

3. That the positioning of staples, i.e. whether they are perpendicular, parallel or at an angle in between to the base line of the shingle, has no great effect on the resistance to tearing of the shingles.

These conclusions apply only to original asphalt-shingle roofs. The use of the stapler method in reroofing work was not a part of the study.

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4. That the positioning of shingles, i.e., whether they are perpendicular, parallel or at an angle in between to the base line of the shingles, has no great effect on the resistance to tearing of the shingles.

These conclusions apply only to original asphalt-shingle roofs. The use of the shingle method in recovering roofs was not a part of the study.

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Correct Application of Asphalt Shingles with BOSTITCH H4 HAMMER and SB7050 ¾" STAPLES

The number of staples per strip and the placing of the staples are both important for maximum holding power. To provide greatest wind resistance, staples should run parallel to butts. With three tab square butt strip shingles, use 6 staples per strip as shown below. Each staple should penetrate 2 courses of shingles.

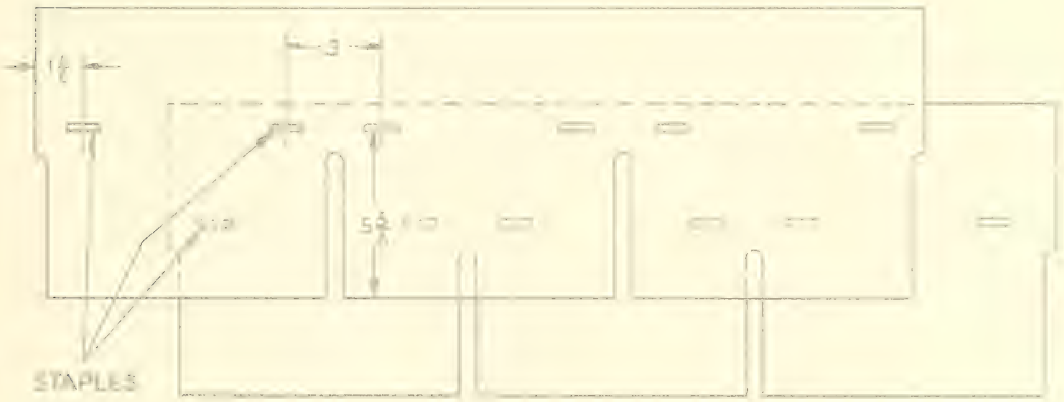

FIGURE 2. INSTRUCTIONS ISSUED WITH STAPLES

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